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One of the most pressing needs in education today is the adaptation of instruction to individual characteristics and background. The Individually Prescribed Instruction project (IPI) of the University of Pittsburgh represents an investigation into the requirements for and the problems encountered in developing a system for individualizing instruction. Among the working aims of IPI are the development of self-directed and self-initiated learners through instructional procedures which provide for self-selection and self-evaluation. The developmental requirements to meet the objectives include the following components: (1) detailed diagnosis is made of the initial state with which a learner comes into a particular instructional situation, and (2) the adaptation of educational alternatives to the performance profiles determined in the student population. Placement tests are given at the beginning of the year to show the relative position of the student compared to the year's end position. Pre-unit tests are also given to determine which concepts of a unit the child has already mastered. Post tests help to evaluate when the child is ready to move on. (Author/KJ)

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One of the most pressing needs in education today is the adaptation of instruction to individual characteristics and background. If anything, this need is even more pressing than it was 43 years ago when a publication of the National Society for the Study of Education pointed out: "It has become palpably absurd to expect to achieve uniform results from uniform assignments made to a class of widely differing individuals. Throughout the educational world there has therefore awakened a desire to find some way of adapting schools to the differing individuals who attend them" (1).

More than ever, our society is committed to the significance of individual performance as opposed to group categorization. Education dedicated to this end can not only maximize individual competence but also provide every individual with a sense of pride, uniqueness, and a feeling of capability to assist, as a full-fledged member, in the development of society.

The Individually Prescribed Instruction project (IPI) of the Learning Research and Development Center, University of Pittsburgh, represents an investigation into the requirements for and the problems encountered in developing a system for individualizing instruction. The broad goals of IPI are not much different from those expressed by others who have seriously thought about their goals. Perhaps though, as scientists and researchers, we are very concerned about the operational mechanisms by which these goals are attained. To recognize them is one thing; to attempt to approximate them is another. A quotation from Professor Jean Piaget states our goals quite well:

> The principal goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done—men who are creative, inventive, and discoverers. The second goal of education is to form minds which can be critical, can verify, and not accept everything they are offered. The great danger today is of slogans, collective opinions, ready-made trends of thought. We have to be able to resist individually, to criticise, to distinguish between what is proven and what is not. So we need pupils who are active, who learn early to find out by themselves, partly by their own spontaneous activity and partly through materials we set up for them. . . . (2)

We certainly agree with these goals of Professor Piaget, but as educational technologists we are greatly concerned about the conditions and the educational environment which bring about such behaviors in the student (3). Consider creativity and originality and the ability to inquire and question. It is likely that these behaviors are brought about by freedom in the classroom—freedom which preserves the individuality of the student and insures that his behavior is shaped as a function of his own productivity rather than by a group norm and blanket classroom approval. Freedom is also fostered by self-reliance—the kind of self-reliance that comes from being able to do certain things independently of others.

Originality is always a problem for the teacher because, on the one hand, the student must have knowledge and skills to be original with, and, on the other hand, he can be taught too much, with little opportunity to discover. Originality, by definition, cannot be taught since if it were taught it would not be original. What we can do is to teach the student to arrange his knowledge and working environment to maximize the probability that original behavior will occur. This can be taught in the context of school subject learning. It is best taught in terms of an individualized instructional system.

A questioning critical approach to knowledge is probably encouraged by the ability of the individual to challenge opinion. Opinion can best be challenged on the basis of information. Information in our society is exploding, and individuals need to develop the capability for self-learning in order to keep from quickly becoming obsolescent. Individualized instruction offers the possibility for teaching students to recognize that they can learn without undue dependence upon the teacher.

These are the underlying aspirations of individually prescribed instruction. These are the goals which an operational system for individualized instruction must seek to maximize. These aspects of learning are difficult to measure. However, the most easily measured products of education are not necessarily the most valuable. Nevertheless, attempts must be made to measure what we say we are after, once we are in a position to have analyzed its nature and how it might be fostered.

Different definitions for individualization can be proposed, but incumbent on each definition is the necessity to point to its operational and practical implications. We define individualization as the adaptation of the educational environment to individual differences; put another way, the use of information about individual differences to prescribe appropriate educational environments.

In its present stage of development, the working aims of the IPI project, which are derived from these major goals and the definition of individualization, are: (1) to provide for reliably assessable individual differences among learners, (2) to develop mastery of subject matter as the child moves through the curriculum, (3) to develop self-directed and self-initiated learners through instructional procedures which provide for self-selection and self-evaluation, and (4) to provide opportunities for the child to become actively involved in the learning process. Of these aims, the first two require further elaboration. The individual differences provided

for can probably be grouped into broad categories which include:

1. Provision for differences in level of achievement among pupils within a given class. This means that the system is so structured that it is possible to determine what each child now knows in each of the curriculum areas and to determine what he is now ready to study.

2. Provision for differences in rate of learning toward certain goals in the curriculum. In the elementary school, in particular, there is a set of learning goals that is common to nearly all students. In order to provide for individual differences in rate of achieving these goals, it is necessary to restructure the materials, the techniques of instruction, and the learning settings in an attempt to maximize each pupil's rate. For the system to meet this need, it has to adapt to at least the gross learning styles of the students. Hopefully, one of the more important outcomes of the work in individually prescribed instruction will be the identification of the various learning styles among students in the same subject areas and within a particular student for different subject areas.

3. Provision for establishing different learning goals for different students. Even though most of the learning goals in the elementary school are common to most students, there are still those goals that can vary from student to student. This is particularly true at the upper levels of the program. The determination of which goals to establish for which student, at present, is a joint decision of the child and the teacher depending upon the child's past experiences and achievement—his own long-range goals and the structure of the subject matter.

Closely related to the provisions for individual differences is the goal of mastery of subject matter. The assumption is that most children can master their subjects if the instructional environment can adapt to their requirements. In the IPI program, mastery is defined as a specified proficiency level for a given objective, plus a specified retention level over a longer period of time. For instance, when a child is learning to add, he works in this area of arithmetic until he can pass a criterion-referenced test on addition, with an 85 percent score or higher. After he has done this and has spent three months during the summer away from school, his retention is checked; if this retention measure indicates that his proficiency level has dropped below 80 percent in addition, he cycles back through this unit before continuing with other units in mathematics. This concern for mastery means that we have to provide for various amounts and kinds of practice, various amounts of time to achieve mastery, and various instructional techniques.

The developmental requirements to meet these objectives can best be thought of in terms of the following components of an individualized system:

1. The outcomes of learning are specified in terms of observable competence and the conditions under which it is to be exercised. In other words, a fundamental requirement in developing an individualized program is to first describe in terms of measurable products and assessable student performance the outcomes of instructional situations. With all the furor that appears to be going on these days about the vices and virtues of behavioral objectives, it is necessary to say that specifying the outcomes of learning in terms of whatever outcomes we can measure does not at all imply that students need be trained to narrow specifications in a production-line manner. On the contrary, vague specification of desired outcomes leaves little concrete information about what the educational process is to strive to attain. Especially important is the fact that interaction between the specification of outcomes in relation to instructional procedures provides a basis for redefinition of objectives. There is a sustained process of clarifying goals, working toward them, evaluating progress, reexamining the objectives, modifying instructional procedures, and clarifying the objectives in light of evaluated experience. This process should point up the inadequacies and omissions in a curriculum. If creativity, inquiry, complex reasoning, and open-endedness are desirable aspects of human behavior, then this needs to be a recognized and assessable goal. A major failing of education has been that overly general objectives have forced us to settle for what can be easily expressed and measured.

2. Detailed diagnosis is made of the initial state with which a learner comes into a particular instructional situation. Without careful assessment of initial learner characteristics, carrying out the educational procedure is a presumption. It is like prescribing medication for an illness without first describing the symptoms. The diagnosis of initial state should include not only assessment of the learner's knowledge of prerequisite behavior but also the assessment of his aptitudes, his learning style preferences (which we do not know how to measure very well), and his perceptual and motor skill capabilities (e.g., whether the student can visually discriminate letter forms and use a pencil). This accumulated diagnosis, or long-term history, must be especially relevant to the immediate instructional step that is to be taken. In contrast to the usual kind of test battery used to predict eventual success in school, measures are required to enable us to suggest to the student what choices are available for his next instructional step. Research data have indicated that the predictors of immediate learning success and the predictors of long-range academic achievement are not necessarily the same factors.

3. The immediate instructional step consists of educational alternatives adaptive to the performance profiles determined in the student population. Alternative instructional procedures are selectively assigned to the student or made available to him for his selection. The range of educational opportunities, including instructional materials and procedures, that need to be made available in a particular school is a matter being determined by experience and study.

In many ways, the materials are the key to providing an individualized program that is both workable and economically feasible. In the more conventional teacher-directed programs, it is possible to use text-

books and materials which permit the teacher to explain procedures and operations before the pupils begin their study. However, in an individualized instruction program, the materials have to be developed, in keeping with subject-matter requirements, for some degree of self-study. Without this option available, the amount of teacher help needed would be unmanageable even with a pupil-teacher ratio of 20-1. This does not mean that even when materials for self-study or independent study are available, they are the only instructional technique that should be employed. It does mean, however, that without the availability of self-study materials, group instruction or tutoring is the only technique possible. For this reason, the emphasis to date in the IPI project has been on the development of materials that can be self-instructional.

4. As the student proceeds to learn from the instructional procedures made available to him, his performance is monitored and continuously assessed—at short or long intervals, appropriate to what is being taught. This monitoring serves several purposes. It provides a basis for feedback and reinforcement to the learner and a basis for further adaptation to his requirements. This short-term learning history, together with the long-term history, provides information regarding assignment of the next instructional unit. It also provides information about the effectiveness of the instructional material or procedure itself.

5. Because assessment, instruction, and performance are interlinked—one determining the nature and requirement for the other—what is to be optimized is critical. Is it retention, transfer to other subject matter, magnitude of difference between pre- and post-test scores, motivation to continue learning, the ability to inquire and explore with the subject matter, and/or all of these? If tracking of the instructional process permits the instructional process to become precise enough, then a good job can be done to optimize some gains and minimize others; and we must take care to assess those ends we are serving and those we are not, although we desire to teach the latter.

6. The recognition of the interrelations among the preceding components leads to the final component of the model: the system has inherent in its design the capability for improving itself. It provides a cumulative bank of knowledge on the basis of which the next time around can be made better than the one that preceded it. One of the real advantages of an individualized instruction program is that this type of system necessitates the collection of large quantities of data just to make it operational. This data that is generated to make the system run can also be of assistance in evaluating the various components of the program such as the objectives, the tests, and the materials. Several examples of the use of data to improve the system are as follows:

Placement tests are administered at the beginning of each academic year to determine general placement of each pupil in each subject-matter area. The information obtained from the placement test shows whether the student gained, lost, or retained the proficiency he showed at the end of the previous school year. Many students who were previously required to meet a high level of mastery showed a lower level of mastery on the placement test and thus were prescribed review work. This pattern has led to an examination of the relationship between the criterion level required for original learning and subsequent retention and review procedures.

A second set of instruments used in the IPI program are the pre-unit tests. These pre-tests measure each of the objectives within a particular unit. Mastery of any of the objectives, as indicated by the pre-test, means that the child can skip these particular objectives and concentrate on those objectives of which he lacks mastery. In addition to providing the student and the teacher with the necessary information about what the child already knows, these instruments also provide the curriculum designer with information relative to sequencing and ordering the objectives within a unit.

Post-tests and curriculum-embedded tests are also used to assist the student and the teacher in making decisions as to when the child is ready to move to the next learning tasks. The curriculum-embedded tests are short check tests embedded within the materials for each objective, while the post-tests are more formal tests given at the end of a unit. In addition to providing information about what the student has learned from a set of lessons, these instruments provide information to the instructional design staff about the curriculum materials, techniques of instruction, and effectiveness of the teacher prescriptions.

Information of the type just mentioned is useful in determining those aspects of the system that need immediate attention and those aspects that can be left alone for the present time. Since individually prescribed instruction is an evolving system, providing information for continuous development and self-correction, one viewing IPI in the 1970's will probably find it very different from what one would see in 1968. Where one now sees the emphasis in testing in assessing achievement measures, in the 1970's one should be able to see instruments measuring other learner characteristics. Where one now sees a rather limited set of materials, one should be able to see a variety of materials designed to meet the individual learning styles of the student. Where one can now see limited kinds of information provided to the teacher, one should be able to see much more information provided quickly and systematically (utilizing computer processing) to assist the teacher in decision making.

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